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SOIL SURVEY

OF

THE BEAR LAKE VALLEY AREA IDAHO

BY

E. N. POULSON, U. S. Department of Agriculture, in Charge
and N. C. DERRICK, University of Idaho

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By E. N. POULSON, U. S. Department of Agriculture, in Charge, and N. C. DERRICK, University of Idaho

AREA SURVEYED

The Bear Lake Valley area is in the extreme southeastern corner of Idaho. It is bounded on the south by Utah, and its eastern boundary is only about 10 miles from the Wyoming State line. It extends north and south through most of Bear Lake County and is separated on the north from the area covered by the soil survey of the Soda Springs-Bancroft area [1] by only one township. The area includes 348 square miles, or 222,720 acres. It is irregularly bounded on the entire west side by the Cache National Forest and on the northern half of the east side by the Caribou National Forest. The northern and southeastern boundaries are arbitrarily drawn where the Bear Lake Valley narrows at the entrance and exit of Bear River. Bear Lake forms the greater part of the southern boundary.

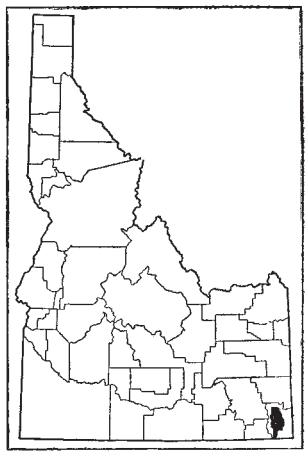

FIGURE 1.—Sketch map showing location of the Bear Lake Valley area, Idaho

The area is skirted by three mountain ranges and a plateau, which almost completely inclose Bear Lake Valley, the principal agricultural section. The foothills of Aspen Range, which lies to the north, almost meet the foothills of Bear River Range, which extends north and south along the entire western boundary. Continuous with Aspen Range, the Preuss Range lies along the eastern edge of the area, continuing to the narrow valley of Bear River, south of which Bear Lake Plateau rises abruptly from Bear Lake and the valley floor.

These natural boundaries, together with Bear Lake on the south, surround a long narrow valley, the main Bear Lake Valley. Immediately north of Bear Lake, the valley is 7 or 8 miles in width. Farther north it widens to 10 or 12 miles. North of Ovid a spur of Bear River Range extends into the valley, narrowing the main valley to an average width between 3 and 5 miles. West of this spur, the narrow valley of Mill Creek extends in a northwesterly direction. In the northeastern part of the area in the spur mentioned a long narrow mountain valley parallels the main valley to the east and is separated from it by a narrow chain of low-lying hills or ridges.

[1] YOUNGS, F. O., KERN, A. J., and POULSON, E. N. SOIL SURVEY OF THE SODA SPRINGS-BANCROFT AREA, IDAHO. U. S. Dept. Agr., Bur. Chem. and Soils, Soil Survey Rpt. (1925), No. 6, 33 p., illus. 1929.

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This is known as the Nounan Valley. It extends south from the northern boundary of the area for about 7 miles. Small valleys or basins fringe these larger valleys, some forming embayments, or indentations, and others being completely isolated. Two spurs of Preuss Range jut boldly into the valley, one southeast of Georgetown and the other east of Montpelier. South of the spur east of Montpelier and some low-lying isolated hills.

The greater part of the valley floors is fairly level. From Bear Lake northward the first-bottom lands lie in the flood plains of Bear Lake Outlet and Bear River. The land at the lake shore lies only a few feet above the lake level. It is probable that at some time, very recent in the geologic history of the valley, the lake continued to the north. This low, flat part of the valley, which averages about 5 miles in width, extends north and south with strikingly regular boundaries through the central part of the valley from the lake to near Bennington.

The land surrounding the low, flat area rises definitely and generally terracelike from this level plain. This part of the valley ranges from fairly level to rough and steeply eroded. On the east, where Bear River enters the area, are tracts of river terraces and alluvial flats. To the north of this, as far as Montpelier Canyon, lie roundly or steeply eroded low chalk hills and old lake beds which form the substratum for a loessial soil mantle. Sharp escarpments and eroded rocky areas are numerous. Fairly flat or rolling alluvial fans lie between these hilly areas and the first bottom.

North of Bennington the alluvial flats of Bear River are very narrow. The spur of the Bear River Range, lying to the west, rises abruptly from these flats. To the east the land rises rather steeply, with many bounding escarpments, and becomes rather gently rolling except where extensive alluvial fans from Preuss Range slope gently and spread fingerlike along stream channels to the alluvial flats. These alluvial fans generally slope very gently and present an appearance of breaking away abruptly from the base of the range.

On the west, the low flat valley plain from the vicinity of Bennington southward to St. Charles is bordered by a narrow belt of flat or gently undulating land which rises terracelike above the first-bottom land. It is rather broken by shallow drainage channels and depressions. Beyond this the relief becomes gently or steeply sloping, the hills rising rapidly into mountainous territory. There are many small alluvial flats along perennial and intermittent streams coming down from the mountains. From Fish Haven southward to the Utah State line the land rises directly from the lake and is gently rolling or steep along the base of Bear River Range. The alluvial flats along Mill Creek and in Nounan Valley are the largest outside of the main valley. The relief surrounding the former is similar to that described. Nounan Valley is an area of rather level or gently sloping alluvial flats and fans. To the east, however, it breaks into gently rolling or steeply sloping hills.

The elevations of the different parts of the surveyed area range from about 5,853 feet above sea level where Bear River flows out of the area to more than 8,000 feet in the mountainous sections. Bear Lake has a mean elevation of 5,924 feet. The first-bottom land in the flood plain to the north is 5,928 feet above sea level at the north

end of the lake. On the highway between Ovid and Montpelier the elevation is 5,923 feet, and at the northern extremity of this flood plain it is 5,914 feet. From this point the narrow alluvial flats drop rapidly with the river.

Most of the towns lie on the terraces and alluvial fans above the low flat plain, and their elevations are strikingly similar. St. Charles, at the northwest end of the lake, is 5,954 feet above sea level. Continuing north on the west side of the valley, the elevation at Bloomington is 5,963 feet, at Paris 5,966 feet, at Ovid 5,933 feet, and at Montpelier 5,963 feet. To the south on the east side Wardboro is 5,952 feet above sea level and Dingle 5,955 feet. East of Dingle where Bear River enters the area the elevation is 5,984 feet. The valley along Mill Creek rises to 6,301 feet at Sharon.

Bear River and its tributaries drain the entire surveyed area. The main tributary is Bear Lake Outlet, which originally drained Bear Lake. This stream was sluggish and meandering and has been replaced in the power developments of the Utah Light & Power Co. by a canal known as the Outlet Canal. Only a few of the other tributary streams are of any great importance, most of them being small and intermittent in flow. During the growing season, many of the stream channels are dry or nearly dry owing to the diversion of water for irrigation.

The natural vegetation in this area is that typical of arid regions of the Northwest. The dominant plant is sagebrush, generally of two species, large and small, but patches of rabbit brush are common. Small-leafed bunch grasses and in places other coarser grasses fill the intervening spaces, making ideal range pasture lands. In the swampy regions of the bottom lands coarse sedges and cattails grow, but on areas flooded only in the spring coarse water grasses and other water-loving flora are dominant. A few higher areas support sagebrush and greasewood.

Bear Lake County, in which this area lies, was organized from part of Oneida County in 1875. Development began in the early sixties, when families settled along the fertile stream bottoms and began diverting much of the available water from the mountain streams for irrigating the arid soils. Early agriculture consisted largely of cattle and sheep raising, owing to the abundance of grazing land. The increase in population, which is largely native born, has been fairly steady.

The 1920 census shows the population of Bear Lake County to be 66 per cent rural. Montpelier, the only town in the county, has a population of 2,984. The rural population is 5,799.

Montpelier is the chief trading center and main shipping point in the county for cattle, sheep, wool, grain, and other products. It is also a freight division for the Oregon Short Line Railroad (Union Pacific system) and is the only town in the area that is served directly by main railway lines.

Paris is a trading center and shipping point for the southern part of the county. Georgetown lies near important phosphate mines which occur to the west of the area in Bear River Range. The other towns are chiefly residential and community centers. Fish Haven is also a bathing resort.

The main line of the Oregon Short Line Railroad (Union Pacific system) runs diagonally across the northern and central parts of the area, passing through Montpelier. From Montpelier a branch line runs to Paris and the phosphate mines to the west.

Graveled roads connect nearly all the towns, and passable dirt roads and trails reach most parts of the area from the main trunk roads. Few roads traverse the flat, poorly drained bottom lands.

Good graded schools are in the towns and outlying districts, and high schools are in Montpelier and Paris. Community meeting centers are well distributed. Telephone service and electric power are available in nearly all the towns and to some extent in the rural districts near the distribution lines.

A very limited market is found for farm produce within the area. Cattle and sheep are shipped principally to Omaha, Denver, Chicago, Ogden, Salt Lake City, or San Francisco. Wheat is shipped east and to Pacific coast points. Wool is shipped east. Dairy products are marketed in Salt Lake City, Ogden, and Pocatello, and in mining centers in Wyoming.

CLIMATE

The Bear Lake Valley area lies in the arid belt of the United States, in the high mountain region of southeastern Idaho. It has the characteristic invigorating cool climate of the northern Rocky Mountain plateau region. There is a wide range in temperature, the atmosphere is dry, and the annual precipitation is light. Both winter and summer are characterized by a large proportion of clear days. The summers are short and cool and the winters long and cold with rather heavy snowfall, especially in the higher-lying parts of the area. Very seldom does the summer heat become oppressive. The average frost-free season is comparatively short, and summer frosts are not uncommon. The prevailing winds are from the southwest.

The annual precipitation is so low as to limit the agriculture of the region. Water from the streams is used as extensively as possible for irrigation, but much of the upland is unirrigated and utilized for dry farming. The main crop here is wheat, to which crop the distribution of rainfall, which is heaviest in spring and early summer, is favorable. Late summer is notably the driest season of the year. It is evident also that dry farming on the uplands is favored by cooler temperature and heavier precipitation than obtain elsewhere, as here the vegetation is more luxuriant and the soils are darker as a rule. This is especially true in outlying valleys and basins and on mountain slopes where snowfall is heavier and thundershowers are more frequent.

The frost-free season is comparatively short, and damage by frost threatens even the hardiest plants. The average frost-free season at Lifton is 137 days, the average dates of the latest and earliest killing frosts being May 11 and September 25, respectively. The latest and earliest recorded killing frosts, respectively, occurred on May 30 and September 4.

The grazing season in the surrounding mountainous territory extends from May to September, but on lower lands it continues for a much longer time. On the bottom lands the choice forage is cut for hay, and the cattle are pastured on the remainder when the range dries up.

Table 1, compiled from data of the United States Weather Bureau, gives the mean monthly temperature and the normal monthly, seasonal, and annual precipitation at Lifton.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Lifton*

[Elevation, 5,950 feet]

Month	Mean temperature	Precipitation		
		Mean	Total amount for the driest year (1924)	Total amount for the wettest year (1923)
	° *F.*	*Inches*	*Inches*	*Inches*
December	22.2	0.85	0.82	0.57
January	19.5	.58	.36	1.47
February	20.9	.62	.26	.11
Winter	20.9	2.05	1.44	2.15
March	27.2	.89	1.36	.62
April	38.6	1.40	.22	1.69
May	52.0	1.03	.69	1.54
Spring	39.3	3.32	2.27	3.85
June	59.8	.69	.33	.66
July	67.0	.92	.45	.93
August	64.6	.74	.34	.72
Summer	63.8	2.35	1.12	2.31
September	55.6	.92	.50	2.28
October	45.2	1.15	1.51	2.43
November	34.5	.78	.26	.39
Fall	45.1	2.85	2.27	5.10
Year	42.3	10.57	7.10	13.41

AGRICULTURE

This area saw its first agricultural development between 1860 and 1870. Settlers were attracted by extensive grazing lands, both on the stream bottoms and in the surrounding mountain ranges. Hay could be cut on the wet bottom land to provide winter feed for cattle and sheep that grazed the valleys and ranges in the summer. Naturally, the main industry became stock raising. Suitable land was irrigated with water diverted from the streams, and the increased area of producing land made possible the production of food for the families and hay for animals.

Census figures show that the most extensive development has taken place since 1900, and with it some changes have occurred in the type of agriculture. Perhaps the greatest change has been caused by the advent of dry farming, as early agricultural development was only under irrigation. Extensive upland areas and valleys were homesteaded for dry farming, and thus the area of range lands available for grazing was reduced. Later, development expanded well into the mountainous region. This land has been fenced but is still utilized largely for grazing. Some small included areas are dry farmed.

Homesteading of range lands, together with restrictions that have been placed on grazing on the contiguous range, has greatly influenced the stock-raising industry. At present, agriculture consists

mainly of the growing of small grains and hay, the raising of livestock, principally cattle and sheep, and dairying. Some poultry is produced. Table 2, giving farm areas and values per farm as reported by the Federal censuses, indicates the trend of agriculture since 1880.

TABLE 2.—*Farm areas and values per farm*

Year	Average farm area	Improved land	Farm investment in—			
			Land	Buildings	Implements	Domestic animals
	Acres	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1880	69.8	98.4	[1] 56.8	----------	9.6	33.6
1890	126.6	42.5	[1] 70.2	----------	6.1	23.7
1900	167.1	56.6	44.6	11.9	5.8	37.7
1910	213.6	64.4	53.7	12.7	4.8	28.8
1920	245.9	53.5	62.9	11.6	6.8	18.7
1925	238.0	----------	63.5	15.9	6.4	14.2

[1] Including buildings.

Though the irrigated acreage at the present time is significant, the greater part of the land is dry farmed. The peak of dry farming came during the World War period. Since then much of the land which may be considered marginal has been abandoned. The irrigated acreage fringes the bottom lands and lies near the sources of water, which is carried only comparatively short distances from the mountain streams. Large irrigation projects with their main trunk canal distributions have not been developed in this area, owing to the fact that the streams are small and well distributed.

On irrigated lands alfalfa is the main crop, though large acreages are devoted to timothy, timothy and clover mixed, and wild hay which is occasionally irrigated to some extent especially when the area is also used as pasture. Smaller irrigated areas are devoted to wheat, oats, barley, potatoes, sugar beets, garden vegetables, and fruits. The extensive bottom lands are used largely in the production of hay and for pasture. Wheat and alfalfa are grown on a few scattered better-drained areas. The dry-farmed land is used chiefly for producing wheat, although considerable acreages are devoted to barley, oats, and rye.

Table 3 gives the acreage and production of the principal crops in Bear Lake County in census years from 1879 to 1924, inclusive.

TABLE 3.—*Acreage and yield of leading crops in Bear Lake County in census years*

Crop	1879		1889		1899		1909		1919		1924	
	Acres	*Bush.*	*Acres*	*Bush.*	*Acres*	*Bush.*	*Acres*	*Bush.*	*Acres*	*Bush.*	*Acres*	*Bush.*
Wheat	1,402	34,859	2,209	52,731	3,229	57,800	8,249	165,779	20,894	186,935	14,195	175,686
Oats	1,143	30,840	1,574	52,265	2,779	78,040	6,578	246,380	3,535	74,717	2,511	62,613
Rye	------	------	------	------	78	850	72	1,659	172	572	11	100
Barley	113	2,536	177	6,059	135	2,980	474	12,717	2,629	22,135	3,134	46,443
Potatoes	------	8,450	334	37,160	323	24,676	469	64,634	313	28,635	147	10,646
		Tons		*Tons*		*Tons*		*Tons*		*Tons*		*Tons*
Sugar beets								2			291	1,475
Hay, all kinds	3,231	3,204	17,335	20,107	------	------	------	------	------	------	------	------
Alfalfa	------	------	------	------	7,116	16,385	8,931	21,725	12,121	17,476	14,092	------
Wild, salt, and prairie grasses	------	------	------	------	29,271	33,216	30,567	33,165	24,724	19,701	19,715	------

The hay produced is nearly all fed to livestock, principally in fall and winter when the animals are driven in from the ranges. Most of the wild hay is cut on the extensive bottom lands, especially in Bear Lake Valley. In the better-drained areas a fair quality of hay is produced from water-loving grasses and fine-stemmed sedges. On marshy areas only coarse sedges grow. These are cut extensively for hay on the border of Dingle Swamp. Yields of wild hay range from 1 to 2 tons to the acre. Timothy and clover mixed are grown on many of the alluvial flats along streams, and yields between 1½ and 3 tons to the acre are obtained. Nounan Valley produces much of this type of forage. Timothy alone, which yields from 2 to 4 tons to the acre, is also grown on these flats but its production is more common on the higher-lying irrigated land. Other cultivated grasses are grown on small acreages.

Alfalfa is grown extensively in the irrigated section and to some extent on dry-farmed land. On the latter areas the yield is very low, and the crop is often endangered by frost. Two cuttings a year are generally made on the irrigated land, where yields total from 2 to 4 tons to the acre.

Wheat is grown principally on dry land, where it is often damaged by frost and drought. In average years it yields from 8 to 30 bushels to the acre. Under irrigation the yield ranges from 35 to 50 bushels to the acre. Dry-farmed land is left fallow in alternate years to conserve moisture. Spring wheat has largely replaced winter wheat in recent years, because the damage from weeds is less to the former. Now the weeds are killed before the spring wheat is sown. Baart is the principal variety grown.

Barley is second to wheat in importance on the dry farms. Oats are grown mainly under irrigation, when they yield from 50 to 85 bushels to the acre. Irrigated barley gives similar yields. Much of these crops is consumed by livestock. A small acreage of rye is grown.

Yields of potatoes range from 75 to 200 bushels to the acre. Sugar beets grown on small acreages around Paris, Bloomington, St. Charles, and Wardboro yield from 5 to 15 tons to the acre. Fruits and vegetables are grown for home use.

When the range season closes in the fall, the cattle are brought to the farms and pastured and later are fed hay. The beef cattle are mainly of the Hereford breed. Sheep are fed on the farms or taken to desert pastures during the winter. A few hogs are raised on most farms, and most farmers keep poultry, mainly chickens.

Dairying has become important in the last few years and shows promise of further development. Large dairy herds, mainly Holsteins, are kept in the valley around Liberty. The produce is shipped out chiefly as cream or butter, but some cheese is made. There are small cheese factories at Georgetown, Paris, and Bern. The coal-mining towns of Wyoming, and Pocatello and Salt Lake City are the principal markets for dairy and poultry products.

Table 4, compiled from census data, shows the value of agricultural products by classes in Bear Lake County in 1919.

TABLE 4.—*Value of agricultural products by classes in 1919*

Crops	Value	Livestock and products	Value
Cereals	$497,079	All domestic animals	$1,764,253
Other grains and seed	575	Dairy products, excluding home use	180,381
Hay and forage	1,060,971	Poultry and eggs	76,735
Vegetables	93,398	Wool	110,382
Fruits and nuts	6,292		
		Total	2,131,751
Total	1,658,315	Total agricultural products	3,790,066

In the dry-farming sections little attention is given to conserving soil fertility. Straw and stubble are generally burned rather than returned to the soil. It is considered difficult to incorporate organic material with the soil without making the land droughty, as moisture during the dry season is insufficient to promote decomposition. Plowing is carelessly done at any time during the open season. This careless treatment is probably afforded the land because dry farming is considered secondary to other industries. Horses generally furnish the power. As many owners of dry-land farms reside in towns or small communities, few good farm buildings have been erected.

As the land is summer fallowed and no crop is grown in rotation with wheat, there is little chance to retain or increase the fertility of the dry land. Practically no commercial fertilizers are used. On the irrigated lands barnyard manure is usually applied, though no pains are taken to conserve it. Alfalfa is depended on to increase and maintain the fertility of the soil and is grown in rotation with other crops every few years. Often, however, alfalfa is allowed to remain on the ground until it is practically worthless for hay.

Nearly all the farm labor is performed by farm families, except at harvest time. Labor is exchanged at the peak of the season, as during grain harvesting and haying. Combined harvesters and threshers are used on some of the dry-land farms.

The range in the size of farms is wide. The irrigated farms are smaller than either the dry farms or those on bottom lands. Some of the irrigated farms comprise only a few acres, and dry-farmed and bottom-land farms may form large ranches of a thousand or more acres.

Dry-farming lands range in value from $5 to $35 an acre, averaging about $25 an acre. Irrigated lands command from $40 to $125 an acre, averaging about $75. Very little land is changing hands at present.

In 1920, 94.9 per cent of the farms were operated by owners, 4 per cent by tenants, and 1.1 per cent by managers. Previous records show similar conditions.

SOILS

The soils of the Bear Lake Valley area are in part related to those of the northwestern intermountain region, in part to those of the northern Rocky Mountain region, and in part to those of the Great Basin region.

The mantle of parent soil materials of the arable soils has been transported by either wind or water, or both, and laid down over a variety of geologic formations and country rocks to which the soils may or may not be related.

Most of the cultivated agricultural lands have developed on deposits of wind-laid materials of fine texture. The influence of this mantle of wind-borne or loessial material superimposed over different substrata is shown in nearly all the soils. The fine floury wind-borne loess has probably been derived from a variety of rocks and materials.

In general, the loessial mantle is thinner than in the extensive loessial region to the northwest, of which region the loessial deposits in this area appear to represent an extreme eastern extension. These deposits occupy terraces and rolling or hilly tracts on both sides of the valley in the northern half of the surveyed area. They extend from an elevation of about 5,900 feet to nearly 6,500 feet. They were formerly much more continuous and extensive, but they have been completely eroded from parts of the valley or are represented only by isolated islandlike areas.

In small patches, associated coarser-textured aeolian or windblown materials appear to have been transported shorter distances and to be derived from adjacent sandy alluvial stream deposits.

The parent soil materials in the larger part of the area are waterlaid. These materials accumulated under varied conditions of relief and drainage and range widely in texture, soil development, and agricultural importance.

The western margin of the valley south of Paris and the northern part of the surveyed area, exclusive of the loessial bodies and areas of nonagricultural rough mountainous land, are dominated by stream-laid materials of alluvial-fan accumulation. Some of these are very old, greatly weathered and eroded, and have lost much of their original smooth alluvial-fan relief. Some are much dissected or occupy local isolated flats and valley basins and are now identified with difficulty with the streams which built them. Others, which are typical on the eastern side of the valley in the vicinities of Montpelier, Bennington, and Georgetown, occur as elongated or broad smoothly sloping alluvial fans of much more recent accumulation. The basic part of these materials was derived from the rocks of the mountains inclosing the valley, but in many places incorporation of loessial material is in evidence to a considerable extent.

The rocks underlying and surrounding the area are extremely varied and complex. They consist mainly of limestone, calcareous sandstone, calcareous shale, and quartzites, chiefly of metamorphosed sandstone and sandstone conglomerate origin.

In the southern and central parts of the valley, the soils have developed from much finer-textured and more completely assorted and stratified materials in which clays and silty deposits predominate. These deposits constitute much of the parent soil material of the low, flat, poorly drained, recent lake plain occupying the broad valley trough north of Bear Lake and are identified with the soil-forming materials of the Great Basin region.

Similar materials gave rise to areas of soils above the lower valley floor north of Montpelier and in the vicinity of Dingle, and other areas, over which loessial or other soil-forming materials have been superimposed, outcrop in eroded terrace escarpments. The older buried lake beds are particularly prominent southeast of Montpelier and north of Paris but they form little of the soil mantle.

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Although the area surveyed is one of low rainfall, an increase in rainfall with increasing altitude and short summer periods with consequent smaller loss of moisture through evaporation have promoted the accumulation of organic matter.

The loessial soils in this area are slightly darker colored and have more definite profile development than the soils of the Snake River plains which developed on similar materials. In some of the alluvial-fan soils and in the low-lying soils of the valley basin, calcareous parent materials and, in the lower areas, impeded drainage have favored further accumulation of organic matter and given rise to extensive areas of dark-colored soils. Rainfall is insufficient to bring about more than rather superficial leaching of the surface materials, and the soils have brown or dark-brown surface layers with moderate or high organic-matter content, and light-colored subsoils with a very high lime content.

The parent soil materials have been subjected to weathering for variable periods of time and under variable conditions of drainage, erosion, and vegetation. Differences in the resulting soil allow classification as old or mature soils with well-developed and stable characteristics and recent and immature soils in transitional or intermediate stages of development. The mature soils have developed the soil profile characteristics of the region. It seems probable that none of the soils are strictly recent, as nearly all show some profile development such as horizontal modification, compaction, and lime concentration in the subsoils. The mature and partly mature soils comprise most of the cultivated soils of the area and are represented by the loessial soils of the Ritzville series and the older-alluvial, alluvial-fan, and terrace soils of the Avon, Hyrum, Millville, Conley, Oxford, and Trenton series. The comparatively recent or immature soils include those of the Logan and Bear Lake series.

The typical mature profile is strikingly developed in the well-drained mature soils, but surface color and organic-matter content differ slightly from place to place, owing to difference in rainfall in various parts of the area. The color of some of the soils is influenced by the color of the parent materials. The average upland soil ranges in color from grayish brown to dark brown; soils occurring at the higher elevations, where the slightly greater rainfall has resulted in a higher organic-matter content, are darker colored, ranging from brown to dark brown; and the lower valley lands, including both mature and immature soils, range in color from light brown through brown to almost black.

The typical mature soils vary to some extent but consist, in general, of the following layers: (1) From 0 to 3 or more inches, thinly plated or laminated slightly coherent light-brown or brown material; (2) between depths of about 3 and 12 inches, finely granular or somewhat cloddy, compact but friable brown or dark-brown material; (3) between 12 and 20 inches, reddish-brown compact definitely heavier material of which the structure ranges from somewhat irregularly to very definitely buckshot or nut, with a tendency toward or a definitely columnar structure; (4) between 20 and 42 inches, a light-gray, light yellowish-brown, or somewhat pinkish compact, hard, and brittle layer of high lime concentration, in which the material is generally nodular and in many places of irregular

nut structure or having netted lime seaming; (5) between 42 and 72 inches, the slightly compact, friable, single-grained, pink parent material tinged with yellowish brown. In many places the younger soils in which development is immature do not have distinct zones of compaction or lime concentration and their layers may or may not be calcareous, depending on the incorporation of calcareous fragments. Poor drainage is perhaps the greatest single factor having pronounced bearing on the profile development of the more recent soils found in the bottom lands and low-lying areas. High lime impregnation is found throughout such soils, and the subsoils in many places are marly and highly stained, mostly green, from the deoxidation of submerged materials. Such conditions obtain especially in the Logan, Bear Lake, and Gooch soils.

Soils of the Ritzville series, which are the most important in the area, developed from aeolian or loessial material. Soils developed from old valley-filling materials of water-laid accumulation include members of the Avon, Hyrum, Oxford, Millville, Conley, Trenton, and Gooch series. The Avon, Hyrum, Conley, Trenton, and Gooch soils are probably modified by aeolian material mainly from inwash. In the Gooch soils normal profile development has been impeded by poor drainage. Recent-alluvial materials have given rise to the Logan and Bear Lake soils, in which no definite profile has yet been established. Miscellaneous materials have given rise to alluvial soils, undifferentiated, peat, coastal beach and dune sand, rough mountainous land, and rough broken and stony land.

Most of the soils are of high lime content. If the surface layer is not limy there is commonly a pronounced accumulation in the subsoil ranging to a soft marly condition or hardpan cementation. Texturally the chief agricultural soils range from fine sand to clay. The dominance of silt loams is noteworthy and the influence of silty materials in many of the other soils is evident.

In this area 15 soil types and 12 phases of types, representing 10 soil series, and in addition 5 miscellaneous classes of material have been mapped. A brief description of the various soil series follows:

The soils of the Ritzville series have friable light-brown or brown surface soils from 8 to 12 inches thick. The surface layer is generally characterized by a thinly laminated or platy structure. The upper part of the subsoils is noticeably heavier in texture and compact and is marked by a distinct color transition to a reddish-brown layer below which is a horizon of high lime concentration, lying at a depth ranging from 16 to 26 inches. The material of this horizon is light yellowish gray or light yellowish brown, is compact and nodular, and in general has an irregular nut structure. It is underlain rather abruptly at a depth of 42 or more inches by smooth, single-grained, unorganized loessial parent material which continues to the underlying substratum of consolidated rocks or unconsolidated old valley-filling material. Ritzville loamy fine sand, Ritzville fine sandy loam, and Ritzville silt loam, with poorly drained and gravelly phases, are mapped.

The soils of the Avon series have dark grayish-brown or dark rich-brown granular friable surface soils extending to an average depth of about 14 inches. Beneath this is a layer, about 1 foot in

thickness, of dark grayish-brown material in many places with a distinct yellowish tinge and having a crumbly nut structure. In many places this layer is very thin or almost lacking in the soils at lower elevations. It rests on a zone of heavy, compact, rich chocolate-brown material having a buckshot or nut structure with columnarlike cleavage. The soil aggregates are covered with vitreous colloidal coatings. This layer is of variable thickness but is generally underlain within a depth of 6 feet by lighter pinkish-brown or grayish-brown material which is more friable than that of the layer above. This is the zone of lime concentration and is seamed with lime in a coarse netted pattern. It contains gravel and cobbles. It in turn rests in many places on grayish-white calcareous almost marly material of undetermined depth. The entire soil may contain bowlders, cobbles, and gravel, generally of quartzite rocks though in some localities they are limestone, sandstone, and shale. The surface soils contain a large amount of loessial material derived from associated loessial soils of the uplands. They are developed on old alluvial-fan deposits flanking the mountains. Avon loam, with a heavy-subsoil phase, and Avon gravelly silty clay loam, with a dark-colored phase, are mapped.

The members of the Hyrum series have rather friable surface soils of grayish-brown or rather dark dull-brown color in which a reddish tint is perceptible in places. The upper part of the subsoil, which generally lies at a depth of about 14 inches, is yellowish brown or light pinkish brown and heavier in texture and more compact than the surface soil. It is underlain by a gravelly and cobbly substratum of grayish-white or pinkish-tinged material containing an accumulation of lime and more or less cemented. (Pl. 1, A.) This horizon is about a foot in thickness and is underlain abruptly by loose cobbles, gravel, and sand. The gravel and stone are of limestone, sandstone, and quartzite. The upper part of the substratum generally lies within about 3 feet of the surface. This layer is derived from weathered old alluvial-fan deposits. Hyrum gravelly fine sandy loam, hardpan phase, and Hyrum gravelly loam, with a heavy-textured phase and a hardpan phase, are mapped.

The Millville series includes soils having very dark dull-gray or black 20-inch surface soils of rather high organic-matter content and containing a large percentage of broken decaying rock fragments of limestone and sandstone origin. The upper part of the subsoils is grayish brown or gray with rust-brown and red iron stains and is seamed with lime accumulations. The lower part of the subsoils is grayish-brown material tinged with green and consisting of cobbles, gravel, sand, and clay. The cobbles and gravel are of limestone and sandstone rocks and are highly lime coated. The subsoils are compact, the fine materials are predominantly of heavy texture, and the entire soil is calcareous. Though they have well-developed profiles, these soils are probably more recent than the Hyrum soils. Millville gravelly clay loam, with a poorly drained phase, is mapped.

The surface layers of the Oxford soils are typically reddish brown or deep reddish brown and heavy, granular, and rather friable. Below a depth of about 12 inches is purplish-red material which tends to be of heavier texture than the surface soil and which has

an irregular nut or columnar structure. The layer of lime accumulation occurs at an average depth of 20 inches and continues for about 2 feet. It is light salmon colored, is high in lime content, and is nodular. Below it lies a zone of banded layers of purplish-red and brown iron-stained red and green materials with less defined laminations within the bandings. This rests on a bed of reddish-brown loose gravel, sand, and clay, in which the gravel increases with depth. This is the only markedly reddish soil in the area. Oxford silty clay loam, with a poorly drained phase and a gravelly phase, is mapped.

The surface layers of the Trenton soils are typically light pinkish brown, grayish brown, or somewhat dull reddish brown or chocolate brown with darker-colored inclusions. They are commonly of rather heavy texture and are thin. In many places the succeeding layer of reddish, chocolate-brown, or pinkish subsoil forms the surface soil. These two layers together average about 16 inches in depth. The next lower layer is rich salmon-colored tough material of somewhat columnar structure and is sprinkled with lime nodules. Below an average depth of 50 inches is vitreous rich reddish-brown heavy-textured columnar material, highly stained and mottled by red and green oxidation and deoxidation coloration. The soils are derived from old water-laid materials and occupy flat terraces. Trenton fine sandy loam and Trenton silty clay loam are mapped.

The Conley soils have very dark brownish-gray or black granular friable surface layers. A large quantity of gravel and, in places, bowlders is present. The upper part of the subsoil occurs at a depth of about 16 inches. It is dull grayish-brown or somewhat purplish-stained heavy material of columnar structure and high colloidal content. It averages about 20 inches in thickness and gives way to a reddish-yellow or reddish-brown stained and mottled layer somewhat less gravelly than the material above. The soil materials are derived from noncalcareous sandstone, conglomerates, and quartzites, and are typically noncalcareous. It is probable that the surface soil has been somewhat modified by loessial inwash. Conley gravelly clay loam, with a gray-subsoil phase, is mapped.

The surface soils of members of the Gooch series are gray, rather dull-gray, or dark brownish-gray granular friable material. The upper part of the subsoil lies at an average depth of 16 inches and consists of lighter-gray material having a slight greenish tinge. It is somewhat marly and heavier in texture than the surface soil. It is underlain at a depth of about 40 inches by material which when freshly exposed is light greenish gray mottled with pink and green and when dry is light gray. Gooch silty clay loam is mapped.

The surface soils of members of the Bear Lake series are typically dark gray or black. Below a depth of about a foot is light-gray or almost white marly material tinged with yellow. This is underlain by the characteristic lower subsoil layer consisting of salmon-pink material. (Pl. 1, B.) This extends to variable depths and rests on gray sand tinged with rust brown and pink and loosely organized but in places showing stratification. This layer rests on a deeper substratum of cobbles and gravel highly stained with iron. The surface soil is distinctly calcareous, and the subsoil is heavily impregnated with lime carbonate, the upper part commonly containing an abun-

dance of lime nodules. Bear Lake fine sandy loam and Bear Lake clay, with an overflow phase, are mapped.

The surface layers of the Logan soils are dark brownish gray or black and are comparatively rich in organic matter. They are distinctly calcareous. The subsoils, which occur within about a foot of the surface, are light yellowish gray or nearly white, are highly calcareous, and are nodular and marly. The lower part of the subsoil is commonly browner in color and may be highly mottled with rust red, green, and blue. Logan clay is mapped.

In addition to the soils described, five miscellaneous classes of materials, including alluvial soils, undifferentiated, peat, coastal beach and dune sand, rough mountainous land, and rough broken and stony land, have been mapped.

In the following pages of this report the soils are described in full and their agricultural adaptations are given; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in Table 5.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in the Bear Lake Valley area, Idaho*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Ritzville silt loam	12,480		Trenton fine sandy loam	2,688	1.2
Gravelly phase	8,640	10.4	Trenton silty clay loam	960	.4
Poorly drained phase	2,112		Conley gravelly clay loam	1,344	2.6
Ritzville fine sandy loam	9,216	4.1	Gray-subsoil phase	4,416	
Ritzville loamy fine sand	1,856	.8	Bear Lake clay	38,720	17.9
Avon loam	11,072	5.5	Overflow phase	1,088	
Heavy-subsoil phase	1,024		Bear Lake fine sandy loam	1,728	.8
Avon gravelly silty clay loam	3,200	2.2	Logan clay	4,288	1.9
Dark-colored phase	1,728		Gooch silty clay loam	1,408	.6
Oxford silty clay loam	384		Alluvial soils, undifferentiated	2,880	1.3
Gravelly phase	832	.7	Peat	12,864	5.8
Poorly drained phase	320		Coastal beach and dune sand	1,664	.7
Millville gravelly clay loam	960	.7	Rough mountainous land	82,304	37.0
Poorly drained phase	640		Rough broken and stony land	4,800	2.2
Hyrum gravelly loam	2,880				
Heavy-textured phase	1,984	2.4	Total	222,720	
Hardpan phase	448				
Hyrum gravelly fine sandy loam, hardpan phase	1,792	.8			

RITZVILLE SILT LOAM

Ritzville silt loam to a depth of 3 inches consists of easily crumbled grayish-brown or brown silt loam with a platy structure. The laminations are about one-fourth inch in thickness. The next lower layer consists of slightly darker and heavier-textured somewhat cloddy friable material of granular structure. This is underlain at a depth of 10 or 12 inches by dull reddish-brown silty clay loam of somewhat irregular nut structure with a tendency to columnar structure but with easy lateral cleavage. These layers are above the zone of lime concentration and do not effervesce with hydrochloric acid. The lime zone, which lies at a depth ranging from 18 to 24 inches, consists of light yellowish-gray or light yellowish-brown silty clay loam of high lime accumulation and of nodular and somewhat irregular nut structure. Lime seaming occurs between the nutlike soil aggregates, and the material becomes very hard and brittle when dry. The lower part of this layer is less nodular and

the lime seaming is more conspicuous. In most places the loosely organized single-grained unmodified parent material occurs at a depth of about 4 feet. This material is yellowish-brown silt loam or heavy very fine sandy loam slightly tinged with pink. The fine sand particles give a gritty feel to the otherwise smooth floury material.

The substratum consists of old valley-filling material, bedrock of limestone, shale, or sandstone, or in places old eroded lake-bed remnants. The soil mantle of loessial material generally averages more than 6 feet in thickness. The parent wind-borne or loessial material has undoubtedly been brought in from extensive areas both local and distant and is rather highly calcareous. Outcrops of the deeper substratum are common, especially in the higher uplands, and around such places the soil is somewhat shallow and is gravelly and stony.

Small unimportant areas of fine sandy loam and very fine sandy loam have been included in mapping. Some areas are calcareous in the surface soil and in few places is the lime leached below a depth of 2 feet. Erosion of the surface soil and exposure of the underlying calcareous material have given rise to many light-colored and shallow areas.

Ritzville silt loam is one of the most extensive and important soils of the area surveyed. It fringes most of the northern half of Bear Lake Valley, and scattered areas also occur in the northern part of the valley in conjunction with the gravelly soils of other series. Here it occupies undulating or hilly areas between fans that spread fingerlike in a southwesterly direction to Bear River. Other areas are adjacent to Nounan Valley. Tracts in the higher uplands are undulating or rolling, hilly, and rough. Most of the soil, owing to elevation, lack of water, or unfavorable relief, is not irrigable. Surface drainage is well developed or excessive, and erosion has been active in places. The water-holding capacity of the soil makes it ideal for dry farming. Only the shallower areas are droughty.

Probably 90 per cent of the soil is farmed. On dry-farmed land wheat is the principal crop, and on the irrigated lands alfalfa leads. Wheat generally yields from 10 to 30 bushels to the acre, though in years of good moisture supply larger yields are reported. Some barley and oats are grown on irrigated areas, yields ranging from 65 to 85 bushels to the acre. Under irrigation alfalfa yields from 2 to 4 tons to the acre. Smaller irrigated acreages are devoted to potatoes and sugar beets. Potatoes yield from 100 to 200 bushels to the acre and sugar beets from 5 to 15 tons. Garden patches and small orchards are to be found on many irrigated farms, and other small areas are used as pasture in conjunction with dairying. Dairying shows promise of future extension. Range cattle and sheep are fed on the ranches in winter.

Dry-farming land of this type commands between $15 and $30 and irrigated land from $60 to $125 an acre. Prices range considerably, depending on distance from town and railroads and on improvements.

This soil is greatly in need of organic matter and nitrates. Any system of farming which tends to retain or increase the proportion of these constituents is to be recommended. The present system is

rapidly depleting the meager supply available. In irrigated areas fertility can be increased and maintained by rotation of other crops with alfalfa in a 3-year to 5-year cycle, together with the application of manure. Rotation of crops on the dry farms is generally impractical, because there is no equally profitable crop which can be used in rotation with wheat.

Ritzville silt loam, gravelly phase.—In general, the gravelly phase of Ritzville silt loam differs from the typical soil only in that gravelly material has been washed over or incorporated with it. In most places the gravel forms only a light sprinkling on the surface. The fragments range from angular to large and rounded. They generally originate from outcropping bedrock or from hill or mountain slopes in the vicinity. Shale gravel tends to make the soil heavier in texture. The material is mostly calcareous and is in many places lighter colored than typical Ritzville silt loam. Other areas, however, notably those north of Ovid bordering the hilly slopes of the spur of Bear River Range, are distinctly darker. The darker soils may owe their color to a higher moisture content resulting from drifted snows and seepage.

This soil occurs chiefly in the western part of Bear Lake Valley north of Paris. Scattered areas are in the uplands east of Nounan Valley. The amount of gravel present is too small to influence cultural practices, production, or value, and conditions given for the typical soil are generally true of this phase.

Ritzville silt loam, poorly drained phase.—Poorly drained Ritzville silt loam resembles the typical soil, but some differences have been caused by poor drainage. The surface soil is calcareous, light grayish brown, and of slightly heavier texture than that of the typical soil. In many places the reddish-brown layer of the typical soil is absent or only faintly discernible and the zone of lime concentration comes within about 10 inches of the surface. The lower part of the subsoil is also lighter colored and lime seamed. The entire soil is somewhat deflocculated and tougher than the typical soil. The poor drainage has brought about an accumulation of alkali salts sufficient to retard growth of crops somewhat.

This soil occurs in flat or slightly undulating areas bordering the bottom lands. Bodies are in the northern and southern parts of Nounan Valley and around Lanark. In the northern part of Nounan Valley, tracts are marked by small depressions and sloughs. The area in the southern part of the valley is rather flat and is broken by drainage depressions. Between Lanark and Paris much of the soil is marshy.

This phase of soil is comparatively unimportant. About the same crops are grown as on typical Ritzville silt loam, but yields are materially lower. Much of the poorly drained soil is used for pasture. Improvement could be made by artificial drainage.

RITZVILLE FINE SANDY LOAM

To an average depth of 10 inches Ritzville fine sandy loam consists of light-brown, slightly grayish-brown, or brown fine sandy loam containing a large quantity of very fine sand. To a depth of 2 inches it is mellow and single grained and shows a tendency to

development of platy structure. Between depths of about 10 and 18 inches is the light reddish-brown loam or silt loam upper subsoil layer. This material is compacted into clods, which break readily. The zone of lime concentration lies below a depth of about 18 inches. It consists of light yellowish-gray heavy loam of somewhat irregular nut or nodular structure, highly seamed or netted by lime accumulations. The material is compact, hard, and brittle when dry but plastic when wet. Below an average depth of about 44 inches is the parent material of highly calcareous light yellowish-brown single-grained smooth mellow fine sandy loam or very fine sandy loam. A small proportion of gravel is nearly everywhere present in this material.

The substratum is very much like that of Ritzville silt loam and its gravelly phase, especially the latter. A few scattered areas are in the hills southeast of Dingle and along Bear River in association with Ritzville loamy fine sand, but the largest area is southeast of Montpelier. This area ranges from undulating or rolling to hilly and rough and is somewhat broken by stony hills and eroded escarpments. In addition to the old valley-filling material of unconsolidated rocks which forms the substratum, chalklike hills and old lake beds underlie considerable of the soil mantle. These formations are highly calcareous, and on eroded slopes where the soil mantle is thin the soil appears light gray or almost white from a distance. The overwash of calcareous material and its incorporation in the soil have left the surface soils calcareous over almost the entire surveyed area. The soil is developed on extensive deposits of loessial material of remarkably uniform texture and good depth. Along the foothills of Preuss Range it approaches very fine sandy loam in texture.

Drainage is good or excessive, but the water-holding capacity is good except in a few shallow areas. This soil is very extensive southeast of Montpelier, where it forms valuable dry-farmed lands. Practically none of it is irrigated. Probably 85 per cent is under cultivation, chiefly to wheat.

The current selling price of this soil ranges from $15 to $30 an acre. Cultural practices are the same as on Ritzville silt loam and the suggestions for the improvement of that soil apply to this.

RITZVILLE LOAMY FINE SAND

Ritzville loamy fine sand consists of loose friable brown, somewhat reddish-brown, or dark-brown loamy fine sand to a depth ranging from 12 to 16 inches. There is a slight tendency to development of platy structure in the surface layer, and below this the material is somewhat compacted as friable clods. The next lower material, to a depth ranging from 24 to 30 inches, is reddish-brown heavy loamy fine sand or heavy fine sandy loam which is more compacted than the surface soil and shows a slight tendency to irregular nut structure. This horizon is leached of lime but is underlain rather abruptly to a depth of about 4 feet by a zone of lime concentration which consists of light yellowish-brown, slightly reddish, or pinkish fine sandy loam. The lime infiltration has given a somewhat netted effect in the lower part of this layer. Below this is the parent material of

yellowish-brown or somewhat reddish loamy fine sand. It is of single-grained structure and is definitely calcareous.

This soil as mapped includes areas sprinkled with gravel, occurring at the confluence of perennial and intermittent streams with Bear River. Many of these areas are lighter in texture than typical. Occurring as they do on low terraces they are frequently flooded and are decidedly grayer in color and somewhat heavier in texture than the typical soil in places. This soil marks a transition to Ritzville fine sandy loam in the higher territory to the east of Bear River, and small undifferentiated areas of that soil may be included in mapping. A small included area east of South Nounan School consists of a foot or two of reddish-brown loamy fine sand overlying a heavy substratum of red clay of either residual or lake-laid accumulation. In many places the heavy clay loam substratum is exposed. Similar exposures of this clay substratum are found in pits, escarpments, and cuts over the area, but this is the only place that it enters appreciably into the formation of the surface soils. This variation is all dry farmed in conjunction with Ritzville silt loam. This soil owes its derivation to wind-blown material of rather coarse texture carried from the channel and alluvial sandy deposits of Bear River. It occurs only in a few narrow strips along Bear River extending from west of Bennington nearly to the northern boundary of the area. Tracts are flat, undulating, or in places hummocky. Surface drainage is good, except where the soil is subject to overflow. In many places the water table becomes high in the spring but recedes later in the season.

Where natural moisture is supplemented by irrigation this soil is fairly productive. Owing to its scattered occurrence only about 60 per cent is under cultivation. Most of it could be farmed. Alfalfa and small grains are the principal crops. Organic matter is badly needed in the soil.

Table 6 shows the results of mechanical analyses of samples of the surface soil and three layers of the subsoil of Ritzville loamy fine sand.

TABLE 6.—*Mechanical analyses of Ritzville loamy fine sand*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
541256	Surface soil, 0 to 16 inches	0.8	0.6	0.6	41.8	24.8	23.4	8.6
541257	Subsoil, 16 to 24 inches	.0	.2	.4	37.9	23.8	26.0	12.0
541258	Subsoil, 24 to 48 inches	.0	.0	.3	23.8	27.5	30.2	18.7
541259	Subsoil, 48 to 72 inches	.0	.5	.6	64.2	18.1	9.8	6.6

AVON LOAM

The surface soil of Avon loam is dark grayish-brown or dark chocolate-brown smooth silty loam to an average depth of 14 inches. The surface 3-inch layer shows a tendency to platy structure. The lower part is finely granular and crumbly. Scattered gravel, mainly quartzites, and some cobbles and a few bowlders are present. The upper part of the subsoil is vitreous dark-brown or grayish clay loam with crumbly nut structure and a tendency to columnar cleavage.

Along the seams are rust-colored iron stains. This layer contains a small quantity of gravel. Below this at an average depth of about 26 inches is highly vitreous rich-reddish or chocolate-brown columnar clay or clay loam. This has a tendency to lateral cleavage and irregular nut structure, and a small quantity of gravel, which increases with depth, is present. This layer extends to a depth ranging from 3 to considerably more than 6 feet. It is of greatest thickness near the base of the mountain slopes, thinning out toward the lowlands. Below this the subsoil is lighter reddish-brown gritty clay loam, fairly friable, and coarsely netted with lime seams. Generally, lime accumulations do not occur above this horizon, in which gravel and cobbles increase in number and are lime coated.

The characteristic substratum is a coarse heterogeneous mixture of old valley-filling material ranging from bowlders to sand, although a solid substratum of shale, limestone, sandstone, and conglomerate occurs in places. Some stony areas in the vicinity of Sharon and Fish Haven are indicated on the soil map by stone symbols. Areas too stony for cultivation have been mapped as rough broken and stony land. In some localities where the gravel has been derived from calcareous rocks the surface soil is generally lighter colored and calcareous. The soil covering is generally favorable in spite of these surface variations. The soil mantle is derived from weathered old water-laid alluvial-fan materials which have in places been modified by admixture of loessial materials.

Areas of this soil range from nearly flat to gently sloping, rolling, hilly, and broken. Lying as they do skirting the mountain slopes they are cut by the channels of numerous perennial and intermittent streams and by depressions subject to seepage. Many of the channels are occupied by soils of the Logan and Conley series, but many pits and poorly drained depressions are included with this soil. Except in such places the soil is well drained on the surface, and subdrainage is good or excessive. The soil has a good water-holding capacity.

This soil ranks with Ritzville silt loam and its gravelly phase in extent and agricultural importance. It occupies extensive areas in the southwestern part of the main Bear Lake Valley, skirting Bear River Range from Paris to the Utah border. Another large area is in the vicinity of Sharon along the same range. The soil is important for dry farming and irrigation. Probably 85 to 90 per cent of it is cultivated and in general is very productive. Probably one-half is irrigated, as it lies in an area of numerous perennial and intermittent streams.

Wheat is the most important crop on the dry-farmed lands. On the irrigated areas alfalfa is the most important crop. Barley, oats, timothy, potatoes, and sugar beets are also grown to a considerable extent. Small family orchards and gardens are on many of the farms.

Dairying is carried on by many farmers to some extent. The poorly drained areas are used as pacture. Some poultry and hogs are raised. Range cattle and sheep are fed most of the hay during the winter.

Dry-farmed land has a value between $10 and $30 an acre, and irrigated land commands from $70 to $125. Very little land is now changing hands.

In general this soil is more intensively cultivated than the soils of the Ritzville series, to which it is comparable. More attention is given to conservation of moisture than on most soils. On the dry land more intensive cultivation for killing weeds and the maintenance of a surface mulch would aid in moisture retention. A shorter rotation of crops, including alfalfa, is recommended for the irrigated areas.

Avon loam, heavy-subsoil phase.—The heavy-subsoil phase of Avon loam has a surface soil similar to that of the typical soil, but the subsoil or substratum is of much heavier material. The surface soil is sprinkled with gravel and in some places is stony to a depth ranging from 6 inches to 2 or more feet. Under this lies a columnar clay subsoil of rich reddish-brown or dull brick-red color, which with depth becomes highly mottled with iron stains and mottles of yellow and green. A very little gravel occurs in the rougher and more elevated areas. Yields and farm practices are similar to those on typical Avon loam.

Table 7 shows the results of mechanical analyses of samples of the surface soil and three layers of the subsoil of typical Avon loam.

TABLE 7.—*Mechanical analyses of Avon loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
541228	Surface soil, 0 to 14 inches	0.1	1.0	0.4	3.2	21.5	58.0	15.6
541229	Subsoil, 14 to 26 inches	.4	.3	.2	1.0	28.4	51.0	19.0
541230	Subsoil, 26 to 70 inches	.8	.7	.6	2.6	26.7	41.6	27.0
541231	Subsoil, 70 to 80 inches	.7	1.2	.8	4.4	17.2	37.4	38.4

AVON GRAVELLY SILTY CLAY LOAM

The surface soil of Avon gravelly silty clay loam is dark dull grayish-brown or dark chocolate-brown finely granular and friable silty clay loam to a depth of about 10 inches. The gravel are subangular or rounded and are of limestone, sandstone, and quartzite rocks. The upper subsoil layer, which is 10 inches thick, consists of dark reddish-brown or dark dull-brown silty clay having a slick or vitreous surface when cut and containing a few gravel. It breaks up into irregular small or large fragments giving a characteristic nut structure which gives cleavage in all directions. It is sticky and plastic when wet. This grades into a layer of similar texture and of lighter or deeper reddish-brown color. It is highly vitreous and has a larger though less definite nut structure than the layer above. The proportion of gravel present is larger. The gravel is lime coated and some is decaying. There is a definite lime accumulation but no cementation in this horizon. Below a depth of about 28 inches is lighter reddish-brown single-grained somewhat friable clay loam or clay definitely patterned with a netting of lime seams. The gravel are less numerous than in the layer above. Below an average depth of about 44 inches lies plastic gritty reddish-brown clay loam or clay having no definite organization but being compacted. The proportion of lime-coated subangular and flat cobbles and gravel increases with depth.

The entire soil is calcareous. Owing to its close association with Ritzville silt loam this soil in many places shows some influence of admixture of silty materials which have been blown or washed in.

The soil is derived from weathered old alluvial-fan deposits, probably modified by later accretion of superficial alluvial materials.

This soil occurs north of Bennington on a large alluvial fan near the base of Preuss Range and spreads fingerlike between large areas of Ritzville silt loam, extending to Bear River. Surface drainage is good and subdrainage good or excessive, except in the narrow strips that extend to Bear River and constitute old intermittent drainage channels and seeped areas. In such places the soil is darker in color. The water-holding capacity is generally good, except on the more gravelly and stony areas.

Agriculturally this soil is similar to the Hyrum soils. Perhaps 90 per cent is under cultivation. Only about one-fourth is irrigated, owing to limited water supply.

Irrigated land of this kind has a value between $40 and $100 an acre and dry-farming land between $10 and $25.

This soil is managed much as is Ritzville silt loam, and suggestions for the improvement of that soil apply to this.

Avon gravelly silty clay loam, dark-colored phase.—The distinguishing feature between this dark-colored soil and typical Avon gravelly silty clay loam is the darker color of the surface soil and upper part of the subsoil of the phase. Drainage appears to be equally as good as in the typical soil, so it seems probable that the darker color results from an overwash of dark-colored sediments. There are few stony areas. Poorly drained areas occur near Bear River.

This dark-colored soil is less extensive than the typical soil, but a larger proportion of it is irrigated. The crops grown, land values, and cultural practices for the two soils are very similar.

OXFORD SILTY CLAY LOAM

Oxford silty clay loam to a depth of about 4 inches consists of reddish-brown, deep reddish-brown, or rich chocolate-brown silty clay loam with a definite platy structure. This is underlain to a depth of about 12 inches by more reddish and slightly heavier-textured material of finely granular structure consisting of purplish-red silty clay of irregular nut structure tending somewhat toward a columnar cleavage. Between depths of about 20 inches and 2 feet is the layer of lime accumulation, consisting of light salmon-colored silty clay containing many lime-carbonate nodules. This material presents an irregular nut structure with more definite lateral than columnar cleavage. At the base of this horizon the lime nodules decrease in number and a lime-seamed effect appears. The next lower material is banded purplish-red, iron-stained, and green sand and clay. The thicker bands break along lines of definite color but include color variations and textural laminations within. There is a sprinkling of gravel throughout. Below a depth of about 64 inches is a zone of loosely organized reddish-brown loamy sand with an increasing amount of gravel toward the bottom. No banding or stratification is here noticeable. The gravel is of limestone and

calcareous sandstone. This is the only definite reddish-colored soil in the area.

This soil occurs north of Montpelier. The relief is gently sloping. Both surface drainage and underdrainage are good. All the soil is under cultivation, and most of it is irrigated. Crop yields are good.

The current selling price of this land ranges from $60 to $110 an acre.

A better rotation, in which alfalfa is not left for so many years, is advised for increased production

Oxford silty clay loam, gravelly phase.—The gravelly phase of Oxford silty clay loam differs from the typical soil only in its greater gravel content. The gravel appears to be an overwash of alluvial materials in most places but occurs to some extent in the subsoil. The proportion of gravel varies considerably, and in places a little stone occurs in areas of lighter texture. In such places the soil is somewhat droughty.

This soil is all under cultivation, and about half of it is irrigated. Crop yields are similar to those obtained on the typical soil.

Oxford silty clay loam, poorly drained phase.—The poorly drained phase of Oxford silty clay loam occupies a low area adjacent to the bottom lands occupied by the soils of the Bear Lake series. Poor drainage has changed the soil somewhat, mainly in imparting higher organic-matter content and darker color to the surface soil.

Hay of good quality is produced, and some areas are used as pasture. This poorly drained soil occurs in a single area in association with typical Oxford silty clay loam.

Table 8 shows the results of mechanical analyses of samples of the surface soil, subsurface soil, and several layers of the subsoil of typical Oxford silty clay loam.

TABLE 8.—*Mechanical analyses of Oxford silty clay loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
541201	Surface soil, 0 to 4 inches	0.0	1.0	0.4	5.6	23.6	50.8	18.8
541202	Subsurface soil, 4 to 12 inches	.0	.4	.1	3.6	25.8	44.8	25.1
541203	Subsoil, 12 to 20 inches	.0	.2	.2	3.2	25.0	46.7	24.8
541204	Subsoil, 20 to 42 inches	.1	.1	.0	2.4	17.4	51.4	28.5
541205	Subsoil, 42 to 64 inches	.2	.4	.5	8.0	29.8	45.5	15.1
541206	Subsoil, 64 to 84 inches	1.6	4.8	3.6	21.4	34.2	25.8	8.8

MILLVILLE GRAVELLY CLAY LOAM

The surface soil of Millville gravelly clay loam is dark-gray or almost black granular crumbly gravelly clay loam about 20 inches thick. Gravel of limestone and sandstone are present. Some of the fragments are in a state of decay and give the soil a speckled effect. The layer is comparatively rich in organic matter. The upper part of the subsoil, to an average depth of about 3 feet, is light grayish-brown gravelly sandy clay loam or clay in which reddish iron stains and a greenish tinge are noticeable. It is sticky when wet but friable and crumbly when dry. The gravel is lime coated and the soil lime is seamed with a netted pattern. This grades into friable, rather

loosely organized grayish-brown or somewhat greenish sandy clay loam or sandy clay with red iron mottles and a high content of lime-coated cobbles and gravel, mostly of highly crystalline fossilized limestone. The entire soil is calcareous. Its origin is similar to that of the Avon and Hyrum soils, but this soil is probably somewhat younger than those.

This soil occurs in a continuous area on an alluvial fan or flat extending northeastward from Georgetown. The soil slopes very gently toward Bear River. Both surface and subsoil drainage are good, and the water-holding capacity is excellent. All the soil is irrigated. It is very productive.

Land of this kind has a current value between $75 and $125 an acre.

Millville gravelly clay loam, poorly drained phase.—Poorly drained Millville gravelly clay loam differs from the typical soil in having a darker soil and higher organic-matter content, resulting from poor drainage. The subsoil has become more pronounced yellowish brown mottled with rust-colored and green stains. Sluggish streams meander over the soil, causing it to be flooded in the spring and wet throughout the year. Willows and grasses are the principal vegetation. The land furnishes excellent pasturage. Artificial drainage would make the soil tillable.

HYRUM GRAVELLY LOAM

The surface soil of Hyrum gravelly loam is dark grayish-brown or dark dull-brown rather friable and finely granular gravelly loam to an average depth of about 14 inches. The surface 2-inch layer shows a tendency to platy structure. The gravel consists of limestone, sandstone, and quartzite ranging from decaying fragmentary flakes to large gravel. The decaying fragments give a highly gritty feel to the soil material. The upper part of the subsoil is light-yellowish or light pinkish-brown material, compacted and typically of somewhat heavier texture and with more pronounced incorporation of gravel than the surface soil. Decaying fragmentary gravel gives a crumbly appearance to this material, which is highly plastic and of high lime content. Below a depth of about 30 inches is a lime-cemented zone generally averaging less than a foot in thickness. It is grayish white and pinkish gray in color and is cemented into a calcareous conglomeratelike mass. The substratum below this breaks rather abruptly to a zone of loose cobbles, gravel, and sand. The color is pale reddish brown somewhat tinged with pink. The entire soil is calcareous. It is probably derived from an overwash of alluvial material from Preuss Range over a substratum of older valley-filling material.

There is a slight transition to a lighter texture in the surface soil toward the mouth of Bennington Canyon, and a few surface stones are present in this locality. Northeast of Bennington an included area represents a transition toward an adjoining area of the dark-colored phase of Avon gravelly silty clay loam, with which it merges.

Most of this soil occurs in a continuous area lying mostly east of Bennington. A smaller tract is in the extreme northeast corner of the surveyed area. In both places the soil lies on gently sloping alluvial fans. Surface drainage is good, and subdrainage is good

or excessive. Small areas near Bear River are poorly drained. The water-holding capacity is only fair.

Though somewhat poor in water retention, probably 95 per cent of this soil is under cultivation, owing to its favorable location. About half the area is irrigated.

Dry-farmed land has a value between $10 and $25 and irrigated land between $40 and $100 an acre.

The raising of other crops in rotation with alfalfa is recommended on the irrigated soils. On dry-farmed lands more attention should be given to the depth and season of plowing. This soil is very poor in organic matter, the incorporation of which is necessary for permanent agriculture.

Hyrum gravelly loam, heavy-textured phase.—Heavy-textured Hyrum gravelly loam differs from the typical soil in the character and texture of the surface material, which seems to have been derived mainly from shale and limestone. It is heavier in texture than the typical surface soil, approaching silty clay loam, and is generally grayer in color. Within the soil itself is some variation, mainly in the proportion of gravel present.

This soil lies mainly within the city limits of Montpelier. Where it merges with Bear Lake clay it shows the effect of past water submergence and is much grayer and is heavy textured. Drainage is at present generally good. The entire area of the soil is irrigated, the crops common on irrigated land being raised.

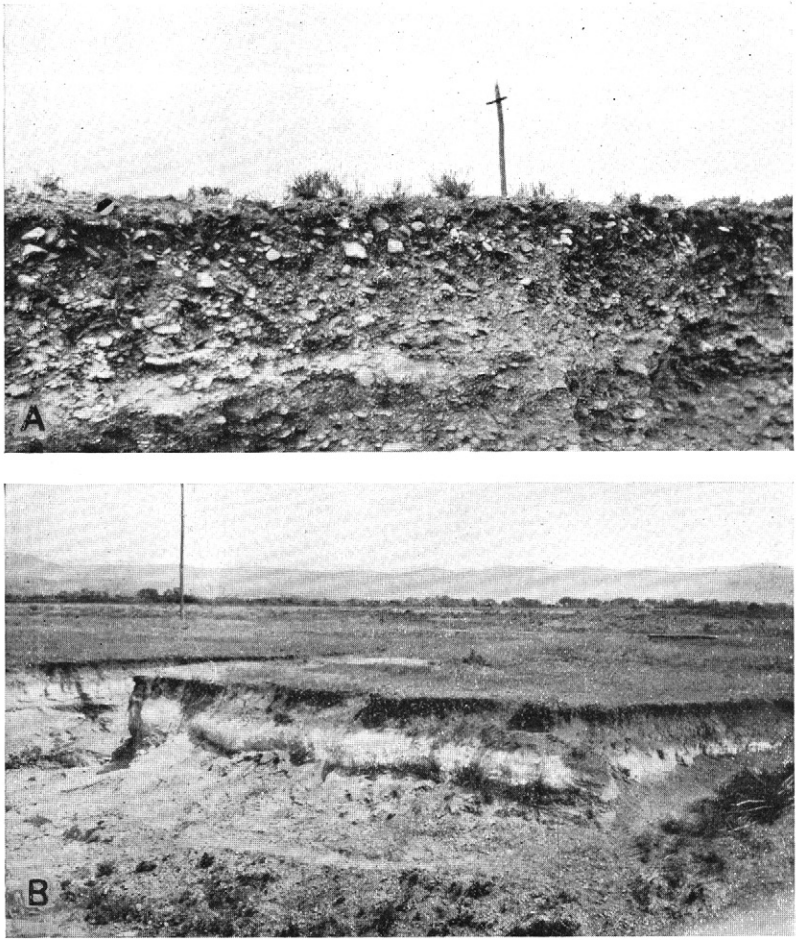
Land values are higher than for typical Hyrum gravelly loam, owing to the location of this phase. Average values are between $75 and $125 an acre.

Hyrum gravelly loam, hardpan phase.—The hardpan phase of Hyrum gravelly loam to a depth of 20 inches consists of grayish-brown friable and crumbly loam with a comparatively high content of gravel and some stone consisting of quartzite and sandstone, together with a smaller quantity of limestone. This layer is not calcareous. It is underlain to a depth of about 2 feet by grayish-brown silty clay loam, having a tendency to an irregular nut structure and slightly lime seamed toward the bottom. Below a depth of about 4 feet is the substratum of cemented limestone conglomerate. This continues to a depth of 6 or more feet, the cementation becoming less and the materials coarser.

This soil occurs in several small areas in the uplands 2 miles north of Bern. Had it been of greater extent it would have been mapped as representing a different series. The relief is similar to that of typical Hyrum gravelly loam. Less than half the soil is farmed, owing to stoniness, but most of it could be put under cultivation.

HYRUM GRAVELLY FINE SANDY LOAM, HARDPAN PHASE

The surface soil of Hyrum gravelly fine sandy loam, hardpan phase, to a depth of about 18 inches is grayish-brown or somewhat rich-brown gravelly fine sandy loam. It is loose, friable, and crumbly and contains a comparatively high percentage of rather subangular and flat gravel, mainly of limestone with a smaller proportion of sandstone. The surface 2-inch layer is of somewhat platy or laminated structure. The entire layer is calcareous, as limestone ma-



A, Profile of soils of the Hyrum series, showing gravelly subsoils with gray layer of lime accumulation; B, profile of Bear Lake soils in Bear Lake flat west of Dingle

terials have been incorporated. The next lower layer, which averages about 6 inches in thickness, consists of lighter grayish-brown compacted somewhat cloddy heavy sandy loam or loam in which the gravel is lime coated and a fine netted pattern of the lime seaming is discernible. This is underlain rather abruptly, at a depth ranging from 24 to 30 inches, by a horizon of lime accumulation which forms the upper layer of the stony and gravelly substratum underlying the soil. This material is a firmly cemented, conglomeratelike hardpan. The color is very light gray or grayish white, the cementing material being lime carbonate. The layer averages about 3 feet in thickness but is highly cemented only at the surface. It gradually breaks away to a loosely organized zone of cobbles, gravel, and sand. The soil is derived from weathering of old alluvial-fan materials with an admixture of materials washed from the surrounding Ritzville soils.

In general the surface soil is of good depth, but some shallow spots occur. In such places the texture also may vary. The relief is gently sloping or slightly undulating, and drainage is good or excessive. The water-retaining properties are not so good as in Ritzville fine sandy loam.

This soil occurs in two areas, one lying north of Wardboro in the region of South Montpelier School and the other near the southeastern boundary of the surveyed area. Most of the soil is dry farmed in conjunction with Ritzville fine sandy loam, and crops and farming practices on the two soils are similar. The soil is probably less productive than the Ritzville soil. A small area bordering Trenton fine sandy loam is irrigated.

TRENTON FINE SANDY LOAM

The surface soil of Trenton fine sandy loam is grayish-brown or dark grayish-brown fine sandy loam to an average depth of about 14 inches. To a depth ranging from 3 to 5 inches there is a surface layer of platy structure. The remainder of the horizon is compacted or somewhat cloddy but is friable under cultivation. The upper part of the subsoil, which is the horizon of maximum lime accumulation, is light pinkish-gray or light yellowish-brown heavy fine sandy loam or heavy very fine sandy loam extending to an average depth of 32 inches. This layer contains a large number of lime nodules and tends to develop a buckshot structure with definite lateral cleavage. It is underlain by uniform pale reddish-brown or pinkish single-grained heavy very fine sandy loam, which is friable but plastic when wet. Below a depth of about 54 inches is slightly lighter reddish-brown loamy sand or fine sand, somewhat stratified and highly iron stained along stratification seams. As exposed in cuts this rests on a substratum of loose stratified cobbles, gravel, and sand with rusty iron stains. The entire soil is calcareous.

In places there is a sprinkling of gravel in the surface soil. The area lying southeast of Dingle has been overflowed and is much broken by old water channels. This has caused some textural variation in the surface soil. In many places the heavier-textured subsoil has been exposed by erosion of surface materials, and in other localities surface materials of either heavier or lighter texture have

been deposited by flood water. In this section also the drainage is only fair, causing accumulation of organic matter and a darker-colored surface soil.

This soil occupies a narrow terrace above the bottom lands, extending along Bear River from Dingle Station to about 2½ miles northwest of Wardboro. Another area lies southeast of Dingle on a terrace south of Bear River. These terraces have been built by Bear River, and probably the parent materials have largely been washed down from Ritzville fine sandy loam which is the soil mantle in the surrounding uplands.

Areas are nearly flat or gently sloping north of Bear River. Here drainage is good, except in some small areas in which there is a trace of alkali. The area south of Bear River lies in the same plain, but the surface has been cut by stream channels. This has affected drainage, and especially in the spring much of the area is wet and marshy. With the lowering of the river later in the season, better drainage is afforded. The porous substratum aids subdrainage. The water-holding capacity is good.

Although comparatively inextensive, this soil is nearly all cultivated and most of it is irrigated. Where drainage is good the soil produces well. Its topography is ideal for irrigation. Alfalfa, barley, oats, potatoes, and sugar beets are grown. The broken and poorly drained areas are devoted chiefly to pasture.

Land of this kind has a current value between $25 and $100 an acre, depending on drainage, location, and improvements.

TRENTON SILTY CLAY LOAM

Trenton silty clay loam to an average depth ot about 8 inches consists of grayish-brown or dark chocolate-brown silty clay loam of somewhat granular structure with rather thick lateral cleavage layers. This material is plastic when wet. The upper part of the subsoil, which is about 8 inches thick, is tough highly plastic grayish chocolate-brown silty clay with definite buckshot structure. This is underlain to a depth of about 50 inches by tough, highly plastic dully vitreous pale reddish-brown or rich salmon-colored silty clay of irregular nut structure, somewhat columnar, and sprinkled with large lime-carbonate nodules. This is the zone of maximum lime accumulation and is underlain by vitreous rich reddish-brown plastic columnar clay highly mottled with rust-colored and green stains. The entire soil is calcareous.

The chief variation in this soil as mapped is caused by erosion of the surface soil, leaving the upper part of the subsoil exposed. Some areas of higher organic-matter content and darker color are also included.

This soil lies on the same plain as the terraces occupied by Trenton fine sandy loam but in complete islandlike isolation in the more recent undifferentiated alluvial soils of Bear River north of Dingle. Areas are flat or gently sloping and are broken by old shallow drainage channels. Drainage ranges from good to poor. All the soil is farmed, mostly under irrigation.

Current land values range from $40 to $75 an acre.

CONLEY GRAVELLY CLAY LOAM

Conley gravelly clay loam consists of very dark dull grayish-brown or grayish-black clay loam to a depth of 16 inches. This is sticky when wet but when dry has a friable consistence and finely granular or nut structure. It has a high content of gravel and in many places is stony, though generally the stones are not numerous enough to interfere with cultivation. It is of high organic-matter content and is underlain by yellowish-gray, yellowish-brown, or somewhat purplish very slick silty clay or clay with iron-rust stains. This layer has a definite columnar structure and breaks readily laterally. When further broken down, it forms a buckshot or fine granular structure. Below a depth of 3 feet lies a layer of pale orange-brown or reddish-yellow heavily iron-stained sandy clay with a high content of gravel and cobbles. This zone is rather loosely organized and is underlain at a depth of about 44 inches by a deeper horizon of lighter orange-brown or yellowish sandy silty clay or sandy clay. The gravel and cobble content is less than in the layer immediately above but increases with depth. The gravel and cobbles throughout are quartzites of highly crystalline structure. None of the soil is calcareous. This is the only soil in the area which is totally noncalcareous apparently due to its quartzite origin.

This soil is characteristically poorly drained except in a few areas lying near the base of Bear River Range. Here the soil may be stony. It is derived from weathered alluvial-fan deposits and is probably younger than the Avon and Hyrum soils.

This soil occupies a comparatively small area in Nounan Valley along Bear River Range. It is nearly all farmed. Fairly well-drained areas are given supplementary irrigation and produce good crops of timothy, timothy and clover mixed, and wild hay. The poorly drained areas are used as wild hay, meadow, and pasture land.

The current selling price of this land ranges from $15 to $60 an acre.

Conley gravelly clay loam, gray-subsoil phase.—To a depth of about a foot, the gray-subsoil phase of Conley gravelly clay loam consists of dull-brown or dark dull-brown somewhat friable finely granular gravelly clay loam. The gravel normally consists mainly of quartzites, but in many places gravel derived from limestones or other calcareous rocks occur. Some areas are stony, but sufficient stone to interfere with cultivation is rare. The upper part of the subsoil is dark grayish-brown silty clay or clay mottled with iron stains and with orange and green. This is much more compacted than the surface soil and in many places shows a somewhat columnar structure. It contains less gravel than the surface soil, but stratified beds of gravel and sands occur in many places. This layer continues to a depth of about 40 inches, where it gives way to greenish-gray or somewhat reddish-gray sandy clay containing a high percentage of cobbles and gravel. Normally the entire soil is noncalcareous except where modified by inwash or overwash of calcareous materials. This soil is derived from alluvial materials which appear not to have been greatly weathered. Its surface materials have undoubtedly been modified by loessial overwash from higher lands.

In extent and distribution this soil is similar to Logan clay. It occupies alluvial bottoms and alluvial fans along perennial and intermittent streams traversing mountain slopes or canyonlike valleys. Drainage is fair, but some areas are flooded and wet in the spring.

This is a productive soil rich in organic matter, and where drainage allows it is cultivated. The remainder is devoted to hay meadow and pasture. Its location is such that nearly all areas can be irrigated.

BEAR LAKE CLAY

Bear Lake clay has a surface soil of very dark dull-gray, grayish-black, or black clay about 1 foot thick. This is coarsely granular and often checks with deep shrinkage cracks when dry but is very stiff and plastic when wet. The surface material is of high organic-matter content and in places contains many grass roots. Small fresh-water shells are present. The upper part of the subsoil is very light-gray or grayish-white, somewhat tinged with yellowish, friable silty clay or clay with somewhat of a buckshot structure in irregular lateral layers when dry. It is of very high lime accumulation and when wet is marly and of puttylike character. Below an average depth of 20 inches is the characteristic lower subsoil layer which consists of salmon-pink more friable single-grained silty clay or silty clay loam from 2 to 3 or more feet thick. The lower part is commonly heavily stained with rust red and green. This is underlain by porous brownish-gray or rust-green and pink-tinged loamy sands without definite stratification which in many places are saturated with water. The entire soil is highly calcareous. In deep exposures it rests in places on highly rust-stained somewhat stratified cobbles and gravel. Minor areas along the course of Bear River have been modified by recent alluvial deposition, but these have had minor effect and are not separated on the map. In such places the soil is lighter colored and lighter textured than typical. In scattered narrow strips in association with Bear Lake fine sandy loam along many of the other channels the texture is somewhat lighter. In the vicinity of Montpelier and north of that place there is gradual transition between this and adjoining soils, and the areas are marked by grayer color and slight texture variations. The southwestern extension of the soil is also marked by light-colored soil areas which lie a little higher and are better drained than the typical soil. In such places there may be an orange-tinged or gray color in the typical salmon-pink subsoil. Such variation also occurs north of Mud Lake in strips bordering the hills or plateau. The texture here is also lighter, probably owing to an overwash from the limestone and sandstone hills although some lighter-textured material may have been deposited by old streams.

The surface soil is of alluvial deposition from a variety of materials, mainly highly calcareous. The flat surface suggests a shallow water deposition in a former extension of Bear Lake, probably before Bear River established its deeper channel in the narrows to the north.

This soil is very extensive. It occupies the lower lake-bottom flat and flood plains of Bear River and Bear Lake Outlet and includes some variations in character. It breaks rather definitely from the abrupt terraces occupied by the bordering soils, but in a few places

the boundaries are not so easily established, owing to washing in of materials by flood waters of the larger streams and alluvial fans. Areas are cut by sluggish streams and old stream channels, some of which now are sloughs and marshes. There are also many small lakes. Dingle Swamp and Mud Lake suggest a comparatively recent extension of Bear Lake. In the spring and early summer, these bottoms are wet and marshy and in general are inaccessible. In the late summer, the water recedes with a consequent lowering of the water table, and wild hay and sedges can be cut for feed. The Outlet Canal, built to replace the ineffective natural Bear Lake Outlet, prevents considerable overflow but plays little part in the subdrainage. Though some areas are comparatively alkali free, alkali accumulations present more or less of a problem throughout this soil. In only a few of the higher spots on which the salts become concentrated does the alkali, which is mostly white, prohibit all growth except of salt grass and greasewood. Such a condition is found in the vicinity of Bern, where the surface soil has become highly deflocculated by black alkali. In the wetter areas the native vegetation is willows, sedges, cattails, and water-loving grasses, and on the higher-lying areas sagebrush, greasewood, and salt grass predominate.

This soil is of low agricultural value. Very little of it is cultivated, but wheat and alfalfa are grown on some small areas. Wheat yields from 20 to 30 bushels to the acre and alfalfa 1 to 2 tons. Natural moisture on cultivated areas is frequently supplemented by irrigation. Areas from which wild hay is cut are also irrigated.

The important crop on this soil is wild hay. Much of the cutting is done well into the marshes where the vegetation is mainly sedges. Such hay is of rather poor quality. Some of the land is used for pasture.

This land has a current value ranging from $5 to $20 an acre.

Bear Lake clay, overflow phase.—The overflow phase of Bear Lake clay is mapped in a small area west of Wardboro which has been overflowed by the flood waters of Bear River and its tributaries, causing a deposition of materials of lighter texture, ranging from silt to fine sand. These materials have modified the surface soil. The greatest deposition is near the streams, where it is in places several feet thick.

BEAR LAKE FINE SANDY LOAM

Bear Lake fine sandy loam to an average depth of about 14 inches is single-grained, friable but somewhat compact, dark grayish-brown fine sandy loam. Under this is friable light yellowish-gray or grayish-white sandy silty clay loam containing a high concentration of lime-carbonate nodules. Below an average depth of about 20 inches is light salmon-pink sandy silty clay loam of modified buckshot structure. This is 2 or more feet thick and is underlain by very loosely organized, porous, unstratified grayish and pale reddish-brown loamy sand with iron stains. The entire soil is highly calcareous. In many places the surface soil contains a small amount of fine gravel and in some places it is grayer than typical. The texture ranges to heavy very fine sandy loam.

The soil is inextensive and unimportant. It occurs in small widely scattered areas throughout the low, flat valley basin occupied by

Bear Lake clay and represents a modification of this soil by lighter-textured materials blown from old water channels. It lies slightly above the level of Bear Lake clay and is better drained. Some areas are devoted to the production of wheat and alfalfa.

LOGAN CLAY

The surface soil of Logan clay, to a depth between 12 and 15 inches, consists of dark-gray or black silty clay or clay, which is very tough and plastic when wet and coarsely granular when dry. The organic-matter content is high, and decaying roots may be present in the surface 3 or 4 inch layer. The upper part of the subsoil is light yellowish-gray or grayish-white clay and is highly calcareous. It is finely granular when dry, highly plastic when wet, and contains an abundance of lime-carbonate nodules. In many places it has a marly or somewhat mealy appearance when disturbed. The lower part of the subsoil consists of rather light brownish-gray or light yellowish-gray silty clay or clay which in many places is tinged or mottled with rust color or green. At a variable depth but generally above 6 feet, this layer is underlain by irregularly and indefinitely stratified layers of clay and sand highly stained with rust brown, yellow, and green. The entire soil is typically highly calcareous. In some localities, notably Nounan Valley, where the origin has been from less highly calcareous materials, the subsoils are not so calcareous and marly and the color transition from the surface soil to the subsoil is more gradual than in the typical soil. Small areas of lighter texture have been included in mapping.

This soil is comparatively inextensive but is widely distributed on alluvial flats along streams and drainage and seepage channels. Areas are along Mill Creek and in Nounan Valley. Drainage is fair or poor, and the land is marshy much of the time. Like the soils of the Bear Lake series, this soil is generally wet during the spring and early summer. Alkali is present in a few areas.

This soil is well suited to use as pasture and meadowland. The native vegetation consists predominantly of water-loving grasses, sedges, cattails, and willows. The hay produced is generally of better quality than that cut from the Bear Lake soils. On the better-drained areas supplementary irrigation is often given.

GOOCH SILTY CLAY LOAM

The surface soil of Gooch silty clay loam to an average depth of 10 inches is light brownish-gray, dull grayish-brown, or brownish-gray friable finely granular silty clay loam. Below this is dark grayish-brown or dark-gray silty clay loam or silty clay, which is highly plastic when wet and coarsely granular when dry. Below an average depth of about 16 inches there is light-gray, tinged with green, silty clay or clay which is of high lime accumulation and is marly. It is plastic and puttylike when wet. Below a depth of about 40 inches is light greenish-gray clay mottled with pink and rust-colored iron stains. The entire soil is highly calcareous.

This soil occupies low-lying flat areas bordering the bottom lands occupied by the Bear Lake soils at Bern and south and west of Bennington. A small area also occurs adjacent to the Logan soils

west of Ovid. Drainage is poor and alkali salts have accumulated in many places. The soil is used chiefly as wild hay and pasture land.

ALLUVIAL SOILS, UNDIFFERENTIATED

The alluvial soils, undifferentiated, occur north and east of Dingle along Bear River and its tributaries. This land represents the results of comparatively recent deposition of sediments by Bear River. The materials consist of undifferentiated sediments ranging from well-rounded cobbles and gravel to sand, silt, and clay, with but little assortment. A few areas that have become flooded year after year have taken on some permanency from deposition of the finer sediments over the cobbly and gravelly substratum.

The areas are much broken by depressions from minor channels. The soil supports a scattered growth of willows, cottonwood, bushes, and grasses. In some areas there is a good soil mantle, of various textures, of grayish-brown surface soils and brown subsoils. Such areas are occasionally cultivated and favorable crop yields are obtained, but the soil as a whole is used principally for pasture.

PEAT

Peat consists of brown or very dark-brown material, generally well decayed though coarse sedge roots in various stages of decomposition are in the surface layer. The material is comparatively loose and spongy and is matted and fibrous at the surface where sedges make a luxuriant growth. This rests on a mineral subsoil which in the surface 20 inches is greenish light-gray silty clay or clay, stained bluish gray in places by surface infiltration. This is highly plastic and has a marly appearance. The lower part of the subsoil is tough, highly plastic, salmon-colored clay with green deoxidation stains. The similarity between the subsoil and that of Bear Lake clay is evident. The peat represents surface organic accumulation from the growth and decay of sedges. Overflowed and swampy conditions are very conducive to their growth.

Peat is mapped within Dingle Swamp. From the edge of the swamp the peat material increases in thickness from a few inches to several feet in the interior of the swamp, which is practically impenetrable. At the southern extremity near the Bear Lake shore and to the north and east of Mud Lake the peat has been modified by sand which has been drifted in by wind. Here the substratum may be sand.

Peat is of little present agricultural value. In the spring Dingle Swamp, where peat is mapped, is almost continuous with the waters of Mud Lake, and it is probable that in the past this lake covered the entire area. At present water-storage operations by the Utah Power & Light Co. cause fluctuations in the size of Mud Lake, so that its waters extend well into the swamp at various times of the year. Sedges for hay are cut along the border of the swamp when the water recedes.

COASTAL BEACH AND DUNE SAND

The areas mapped as coastal beach and dune sand lie on the west and north beaches of Bear Lake. The material consists chiefly of coarse drifting dune sand with considerable gravel, especially in the

underlying material. In the western part of the area a very thin covering of shore wash consisting of organic matter, shells, and other débris has encouraged the growth of water-loving flora, principally sedges, and the matting of vegetative covering has stopped drifting. The rankest growth is in the swampy area on the immediate shore line.

ROUGH MOUNTAINOUS LAND

Rough mountainous land includes those parts of the area composed of the mountain ranges and larger hills. These areas are generally badly dissected by ravines and stream courses, and the relief is steep and unfavorable for cultivation. The soil is chiefly nonagricultural, though included small scattered areas may be capable of cultivation. Such areas, however, are practically inaccessible or are too remote to be of much value under present economic conditions. The land has some value for grazing sheep, cattle, and horses.

The soils of these rough areas are not classified in detail. For the most part the soil mantle is thin and broken by outcrops of underlying rocks. The color ranges from light gray or light brown to dark gray or very dark brown. The rocks are chiefly sedimentary and highly calcareous limestones, shales, and calcareous sandstone and conglomerate. Areas in the Bear River Range are underlain by quartzites.

Besides grass and small flowering plants, the vegetation consists of sagebrush, fir, pine, aspen, juniper, mountain maple, birch, serviceberry, chokecherry, hawberry, and other bushy trees and shrubs.

ROUGH BROKEN AND STONY LAND

Rough broken and stony land consists of low-lying rough stony hills, canyon walls, steep broken slopes, escarpments between terrace levels and upland, and areas of excessively stony soils. It is typically entirely nonagricultural, but it affords some grazing. The vegetation is principally small-leafed grasses and sagebrush.

IRRIGATION

The principal limiting factor in plant growth on all the upland soils of the area surveyed is lack of moisture. This is partly overcome in the dry-farming sections, which constitute more than half the agricultural upland territory, by summer fallowing in alternate years. However, it is appreciated that to prevent crop failure and to get maximum yearly yields land must be irrigated. Streams have been diverted for this purpose wherever possible and the available water supply has been utilized. The water supply fluctuates, especially in the intermittent and smaller perennial streams, with the fluctuation in annual snowfall in the mountains, so that only where water is diverted from the larger streams is a constant supply assured.

No extensive irrigation systems have been developed, principally because of the lack of any large source of supply at elevations allowing diversion by gravity flow and because of unfavorable surface features. The largest individual supply is Bear River, from which diverted water irrigates the territory around Dingle and a narrow

strip on the first terrace north to Montpelier. In general Bear River lies too low for further development. Other streams from which the larger supplies are drawn are Montpelier, Threemile, North, Mill, Paris, Bloomington, St. Charles, and Fish Haven Creeks.

Supplementary irrigation is often given the wild hay on the bottom lands. The method employed here is flooding. On the higher irrigated lands the principal crops are alfalfa, small grains, potatoes, and sugar beets. The furrow or corrugation methods are employed for the potatoes and sugar beets, and both flooding and corrugation methods are used for alfalfa and grains.

DRAINAGE AND ALKALI

As drainage is well developed over the greater part of the principal agricultural soils accumulation of alkali salts associated with poor drainage has not taken place to any appreciable extent. There are, however, alkali accumulations in the Bear Lake soils which constitute the first-bottom lands in the valley floor of Bear Lake Valley and in some low-lying soils bordering these soils directly. Because the alkali so clearly characterizes soils of this series and directly associated soils it was not felt necessary to construct a special alkali map or to designate the alkali areas on the soil map. The Bear Lake soils constitute the drainage basin into which all drainage waters of the area flow. Yearly flooding of these soils has prevented dangerous accumulation, except in a few small spots, but it has caused such a wide dispersion of the salts that none of the soil is totally free from alkali. The salts consist principally of white alkali but in a few areas near Bern accumulations of black alkali salts, which have caused deflocculation of the soil, are to be seen in both the Bear Lake and Gooch soils. Here greasewood and salt grass constitute the vegetation.

Along the edge of the areas of Avon loam bordering Bear Lake clay in the southwest part of the surveyed area there are numerous seeped areas and poorly developed drainage channels running toward the mountains. Here slight alkali accumulation has taken place. Much of the salt concentration is in the Logan soils, but the Avon soils are also affected. Irrigation has aggravated this trouble, as there has been no associated drainage development. A similar but much more extensive area lies to the north in the vicinity of Lanark. Here the alkali accumulation is sufficient to retard growth somewhat but not to kill vegetation. This accumulation is in the poorly drained phase of Ritzville silt loam. Artificial drainage should be established.

Immediately north of Wardboro in areas of Trenton fine sandy loam there is also slight alkali concentration.

MOISTURE EQUIVALENT DETERMINATIONS

Duplicates of the official soil samples collected for the Bureau of Chemistry and Soils were forwarded to the University of Idaho, where moisture-equivalent determinations were made. The results are given in Table 9.

TABLE 9.—*Moisture equivalent of soils of the Bear Lake Valley area*

Soil type	Sample No.	Depth	Moisture equivalent	Soil type	Sample No.	Depth	Moisture equivalent
		Inches				*Inches*	
Ritzville loamy fine sand	541256	0–16	15.7	Millville gravelly clay loam	541221	0–20	26.7
Do	541257	16–24	17.4	Do	541222	20–36	26.1
Do	541258	24–48	18.9	Do	541223	36–72	21.3
Do	541259	48–72	8.7	Conley gravelly clay loam	541224	0–16	29.3
Ritzville fine sandy loam	541267	0–10	15.3	Do	541225	16–36	25.2
Do	541268	10–18	16.6	Do	541226	36–44	16.1
Do	541269	18–44	19.5	Do	541227	44–72	21.2
Do	541270	44–72	12.5	Trenton fine sandy loam	541248	0–14	16.4
Ritzville silt loam	541207	0– 3	22.3	Do	541249	14–32	25.9
Do	541208	3–12	23.1	Do	541250	32–54	18.3
Do	541209	12–20	21.9	Do	541251	54–72	13.9
Do	541210	20–48	25.8	Trenton silty clay loam	541252	0– 8	25.4
Do	541211	48–72	24.1	Do	541253	8–16	23.8
Hyrum gravelly fine sandy loam, hardpan phase	541244	0–18	22.5	Do	541254	16–50	23.8
Do	541245	18–24	21.5	Do	541255	50–72	34.6
Hyrum gravelly loam	541217	0–14	24.4	Gooch silty clay loam	541263	0–10	38.3
Do	541218	14–30	20.0	Do	541264	10–16	34.6
Do	541219	30–42	14.5	Do	541265	16–40	33.9
Do	541220	42–72	10.9	Do	541266	40–72	30.8
Avon gravelly silty clay loam	541212	0–10	26.0	Avon loam	541228	0–14	27.3
Do	541213	10–20	26.5	Do	541229	14–26	24.9
Do	541214	20–28	24.7	Do	541230	26–70	29.0
Do	541215	28–44	24.6	Do	541231	70–80	35.6
Do	541216	44–72	21.6	Bear Lake clay	541236	0–12	33.4
Oxford silty clay loam	541201	0– 4	23.4	Do	541237	12–20	37.3
Do	541202	4–12	21.7	Do	541238	20–54	20.1
Do	541203	12–20	21.8	Do	541239	54–72	4.1
Do	541204	20–42	25.3	Peat	541260	0–20	Peat.
Do	541205	42–64	21.9	Do	541261	20–40	25.5
Do	541206	64–84	14.3	Do	541262	40–72	23.4

SUMMARY

The Bear Lake Valley area lies in the extreme southeastern part of Idaho, extending centrally north and south nearly through Bear Lake County. Its total extent is 348 square miles, or 222,720 acres.

Most of the area constitutes a single large valley to the north of Bear Lake, lying between Bear River and the Aspen and Preuss mountain ranges. A spur of the valley extending into Bear River Range and Nounan Valley are the only outlying valleys included. Bear River is the only drainage outlet. Most of the area, except the main valley floor first-bottom lands, is well drained.

This area was first settled in the early sixties. Most of the inhabitants are engaged in farming and stock raising.

Montpelier is the only city in the area. Paris is the county seat of Bear Lake County.

Railroad facilities are good, and there is a fairly good system of roads.

The important crops are wheat, alfalfa, wild hay, timothy, timothy and clover mixed, barley, oats, potatoes, and sugar beets. Dairying is increasing in importance, and stock raising is very important. Wheat, livestock, wool, dairy products, and sugar beets find markets outside the area.

More than half the agricultural area is dry farmed. The remainder comprises irrigated land and wild meadowland. Lack of moisture is the principal limiting factor in the agriculture of the area.

The soils of the area have been classified in 10 soil series, represented by 15 soil types and 12 phases. In addition, five miscellaneous classes of land are mapped. The texture of the soils ranges from fine sand to clay. The upland soils range in color from grayish or light brown to dark brown and the bottom soils from light gray to black.

The soils of the Ritzville series are very important agriculturally, as is also Avon loam. Most of the Oxford soils are cultivated, and the Millville soils are used in the production of crops and for pasture. The Conley soils are only fairly well drained and are used mainly as pasture and meadow. The Trenton soils are fairly well drained and are largely cultivated. Gooch silty clay loam is a meadow and pasture soil. The Bear Lake soils are poorly drained first-bottom soils used as pasture and wild-hay land. The Logan soils are of alluvial origin and are poorly drained. They are used mainly in the production of wild hay and as pasture land.

Of the miscellaneous materials mapped peat, coastal beach and dune sand, and alluvial soils, undifferentiated, have a small agricultural value. Rough mountainous land and rough broken and stony land are largely nonagricultural but furnish extensive grazing areas.

Irrigation is necessary for intensive farming and maximum yields without crop failure. Drainage is good in most of the upland soils, but extensive areas of the bottom lands are poorly drained. Light alkali accumulations are found on some of these areas.

○

[PUBLIC RESOLUTION No. 9]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture"

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]

Areas surveyed in Idaho, shown by shading

U. S. GOVERNMENT PRINTING OFFICE: 1930

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U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
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CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
BEAR LAKE VALLEY AREA
IDAHO

UNIVERSITY OF IDAHO
COLLEGE OF AGRICULTURE AND
AGRICULTURAL EXPERIMENT STATION
E. J. IDDINGS, DEAN AND DIRECTOR
G. R. McDOLE, IN CHARGE SOIL SURVEY

CARIBOU NATIONAL FOREST
CACHE NATIONAL FOREST
BEAR LAKE
MUD LAKE
DINGLE SWAMP
Georgetown
Bennington
Montpelier
Paris
Bloomington
St. Charles
Fish Haven
Ovid
Liberty
Wardboro
Dingle
LEGEND
Avon loam
Heavy subsoil phase
Avon gravelly silty clay loam
Dark colored phase
Bear Lake fine sandy loam
Bear Lake clay
Overflow phase
Conley gravelly clay loam
Gray subsoil phase
Gooch silty clay loam
Hyrum gravelly fine sandy loam, Hardpan phase
Hyrum gravelly loam
Heavy textured phase
Hardpan phase
Alluvial soils (Undifferentiated)
Coastal beach and dune sand
Logan clay
Millville gravelly clay loam
Poorly drained phase
Oxford silty clay loam
Poorly drained phase
Gravelly phase
Ritzville loamy fine sand
Ritzville fine sandy loam
Ritzville silt loam
Poorly drained phase
Gravelly phase
Trenton fine sandy loam
Trenton silty clay loam
Peat
Rough mountainous land
Rough broken and stony land
CONVENTIONAL SIGNS

Macy H. Lapham, Inspector, District 5.
Soils surveyed by E. N. Poulson, U. S. Department of Agriculture, in charge, and N. C. Derrick, University of Idaho.

Scale 1 inch-1 mile

BASE MAP IN PART FROM U. S. GEOLOGICAL SURVEY SHEETS

Field Operations
Bureau of Soils
1926